Integrated Water Quality and Aquatic Communities Protocol – Wadeable Streams

Appendix A: Annual Report from Pilot Project

Draft Version 1.0

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This appendix contains a typical annual report that will be developed after each sampling cycle for wadeable streams. It is written in the format for publication as part of the Natural Resources Technical Report.

National Park Service
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Integrated Aquatic Community and Water Quality Monitoring of Wadeable Streams in the Klamath Network – Annual Report

2009 results from Pilot Project in Redwood National and State Parks

Natural Resource Report NPS/KLMN/NRTR—2010/XXX

ON THE COVER
Bridge Creek, Redwood National and State Parks.
Photograph by: Travis Albert

Integrated Aquatic Community and Water Quality Monitoring of Wadeable Streams in the Klamath Network – Annual Report

2009 results from Pilot Project in Redwood National and State Parks

Natural Resource Report NPS/KLMN/NRTR—2010/XXX

Dr. Eric Dinger
Klamath Inventory and Monitoring Network
Ashland, OR 97520

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U.S. Department of the Interior
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Fort Collins, Colorado

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Contents

Figures

Page

Tables

Page

Preface

This report is meant as a stand-alone progress report on the wadeable streams monitoring of the Klamath Inventory and Monitoring Network. The intended audience is park managers, park specialists, interested regional scientists, and the general public. Although many details concerning the protocol are best obtained from reading the entire protocol, it is our aim that this report be understandable without further reading. The format and level of detail chosen to achieve this is similar to a scientific publication, albeit with the goal of reaching a broader audience. The topics covered by these reports, written every 3 years at the completion of a sampling period for the lakes of the Network are: (1) lists of streams sampled, with basic parameters summarized; (2) biodiversity information (invertebrates, fish, amphibians) of each stream; (3) status and condition estimates where applicable; and (4) interesting findings of special significance to the audience.

Due to the timeline for protocol submission, this draft annual report did not receive review from park staff specialists to tailor the format to their needs. In the first years of protocol implementation, the annual reports will be critically reviewed by all intended audiences and refined iteratively to achieve the necessary goals.

Executive Summary

In 2009, the Klamath Inventory and Monitoring Network initiated a pilot project of wadeable stream monitoring protocols in Redwood National and State Parks. The purpose of the project was to field test draft standard operating protocol methods for evaluation of suitability and feasibility. This report serves as a draft example of the expected types of data to be reported from the final implementation of the protocol.

A total of 22 stream sites on 11 streams were visited from 18 August to 30 September 2009. The methods based on the US Environmental Protection Agency Environmental Monitoring and Assessment Program (EPA EMAP) protocols. These methods were largely successful and a prominent finding was the need to use electrofishing to obtain the best data on vertebrate distribution.

The streams of Redwood National and State Parks were characterized by low acid neutralizing capacity, with several streams having values below NPS and EPA threshold of 20 mg/l. However, this is likely the result of both small watershed and local geology. It does highlight the susceptibility of the streams to acidification from acid rain or acid mines. Among other water quality standards, there were no exceedances in: Chloride, Total nitrogen, pH, Sodium, or Sulfate.

A total of 17,677 individual macroinvertebrates from 153 distinct genera were identified by the contract laboratory. A total of five amphibian species were observed: Foothill Yellow-legged Frog (*Rana boylii*), Olympic Salamander (*Rhyacotriton olympicus*), Pacific Giant Salamander (*Dicamptodon ensatus*), Tailed Frog (*Ascaphus truei*), and Western Toad (*Bufo boreas*). Of these, the Pacific Giant Salamander was the most ubiquitous (17 sites) and the Olympic Salamander was the rarest (single site: Godwood Creek). Eight distinct fish species were observed snorkeling, however, and life stages prohibited the identification of all species (Table 6). Species confirmed were: Coho Salmon (*Oncorhynchus kisutch*), Cutthroat trout (*Oncorhynchus clarki*), Steelhead trout (*Oncorhynchus mykiss*), and Three Spine Stickleback (*Gasterosteus aculeatus*). Lamprey ammocetes (larval fish) were observed only when electrofished, but the life stage prevented species identification. Sculpin was also observed, but no confirmed species identification was made.

Results of the Northern California Coastal IBIs suggest that the streams of REDW are all at least in "Good" condition, with some sites in the "Very Good" category. The application of the EPA threshold of "52" to indicate impairment (<52: unimpaired; ≥52 impaired) from Stoddard et al. (2005) shows that no sites within REDW are impaired based on macroinvertebrate assessment.

Acknowledgements

We thank Daniel Sarr at the Klamath Network for his contributions to the developing the Water Quality monitoring protocols of the network. Park staff at Redwood National and State Parks helped implement and improve the quality of the work, especially David Anderson and Vicki Ozaki. Special thanks to the Klamath Network staff: Sean Mohren, Bess Perry, and Lorin Groshong. Sean Mohren designed the stream database and helped improve the wildlife biology portions, especially amphibians. Bess Perry assisted with many details, and so much more. Lorin Groshong ran the GRTS draw for site selection and helped with the last minute determination of sites on the topo maps. The field crew, led by Charles Stanley, also deserves special mention for their ability to work in the challenging conditions of the redwood forests.

Introduction

The Klamath Network vital sign selection process resulted in the identification of two aquatic resource vital signs for monitoring: Aquatic Communities and Water Quality (Sarr et al. 2007). Prioritization of these vital signs was driven by potential natural and anthropogenic stressors on water resources (including physical, chemical, and biological characteristics) of freshwater habitats and resources.

The Klamath Network is located in southern Oregon and northern California and includes the National Park Service units of: Crater Lake National Park (CRLA), Lassen Volcanic National Park (LAVO), Lava Beds National Monument (LABE), Oregon Caves National Monument (ORCA), Redwood National and State Parks (REDW), and Whiskeytown National Recreation Area (WHIS). Of these, LABE does not have any surface water resources, and is hence not covered by this protocol.

During the scoping process and Vital Sign determination process (detailed in Sarr et al. 2007), an emphasis was put on two aspects of the water quality monitoring: (1) a probabilistic sample, allowing determination of park wide status and trends; and (2) an integrated ecosystem approach to monitoring. To accomplish the first aspect, we implemented a spatially-balanced probability sampling throughout the park boundaries, called Generalized Random Tessellation Stratified - (GRTS). This procedure is random, but by spatially balancing the spread of sites, it ensures that all areas of the park are represented in the sample. To accomplish the second aspect, we are sampling as much of the components of the ecosystem as possible: physical habitat, water chemistry, riparian zones, macroinvertebrates, amphibians, and fish. By sampling all of these (balanced against what is logistically and financially possible), an integrated approach to monitoring ecosystem change can be had.

This annual report details the results of the monitoring of 22 sample reaches on 11 streams of Redwood National and State Parks sampled as a part of the pilot project developing the monitoring protocol. The full objectives of the wadeable streams protocol are presented in the protocol narrative (Dinger et al., in development [this document]). This annual report focus on portions of the objectives, mainly the characterization of the habitat, water quality, and biotic communities in a probabilistic sample wadeable streams and provides estimates of status and condition.

Methods

Study Site

This project was carried out in Redwood National and State Parks (REDW), which is in coastal northern California and is composed of Redwood National Park, Prairie Creek, Del Norte Coast and Jedediah Smith State Parks. Redwood National and State Parks covers 131,983 acres of coastal redwood forests, prairies and seashores, including 38,982 acres of old-growth redwood forests.

In this report, we visited a total of 22 sample reaches on 11 streams (Table 1, Figures 1 and 2). Two of these streams were "judgment" streams selected by REDW park staff in the development stage of the protocol (Redwood Creek and Godwood Creek). Redwood Creek was selected for a history of disturbance (logging roads) and being a 303d site for temperature and sediment. Godwood Creek was selected as an example of a pristine, old growth forest stream. The remaining streams were chosen using GRTS and sampling sites on the stream were randomly selected thereafter. Each site was assigned a unique code from the GRTS procedure.

Water Chemistry

In a well mixed riffle, a 1 liter amber high-density-poly-ethylene (HDPE) sample bottle was submerged to collect the water sample. On shore, using a 60 ml syringe and filter holder, each water sample was filtered through a 0.45 µm nylon membrane filter into an amber, HDPE, acid washed 250 ml bottle. After 250 ml were filtered, the bottle was capped and kept cool until able to freeze (generally <4 hours). These samples were then shipped to the Cooperative Chemical Analytical Laboratory at Oregon State University, Corvallis. These samples were analyzed for: anions (Ca^{2+}, Na^{+}, K^{+}, and Mg^{2+}); cations (SO_4^{2-} and Cl^{-}); and nutrients (total dissolved nitrogen, total dissolved phosphorous).

In the same riffle, a Eureka Environmental "*Manta*" water quality probe and "*Amphibian*" pocket PC data logger were used to take seven cross-section measurements of temperature, pH, conductivity, dissolved oxygen, and turbidity.

Stream Habitat Characteristics

Stream habitat parameters were sampled using protocols based on the US Environmental Protection Agency Environmental Monitoring and Assessment Program protocols. In short, a sample reach 40 times longer than the average wetted width of the stream is set up with 11 equally spaced transects within the sample reach. A maximum reach length of 500 meters was imposed, as well as a minimum reach length of 150 meters.

At each transect, we collected measured cross-sectional information on wetted width, depth, embeddedness, and substrate. In the middle of the stream, we collected measures of overhead shading with a convex, spherical densiometer. Areal categorization of habitat cover in the following classes were estimated: Artificial substrate, Boulders, Filamentous Algae, Large wood, Macrophytes, Overhanging banks, Roots, Small wood, and Undercut banks. At each transect, visual searches for invasive plant species were conducted. Other data were collected on the riparian plant community structure, dominant trees, and bank characteristics but are not presented here.

Table 1. Streams sampled during pilot project, date sampled, location, and basic stream parameters. * indicates slope at this site was below the resolution of the method. – indicates no discharge available due to equipment malfunction. Watershed size estimated using the USGS National Map Viewer.

Stream Name	Unique Site Code	Date Sampled	Latitude	Longitude	Slope(%)	Discharge m^3/s	Discharge ft^3/s	Watershed size (km^2)
Bummer Lake Creek	09B	8/25/2009	41.74364	124.05185	4.5	0.02	0.54	9.7
Bummer Lake Creek	09K	9/2/2009	41.74345	124.05522	6.0	0.02	0.77	10.7
Damnation Creek	04B	8/21/2009	41.65646	124.12613	2.8	0.01	0.22	3.7
Damnation Creek	04K	9/4/2009	41.66034	124.12541	2.4	0.01	0.18	3.2
East Fork Mill Creek	101	9/9/2009	41.72563	124.07963	0.8	0.05	1.90	33.0
East Fork Mill Creek	14J	9/10/2009	41.72940	124.09235	0.5	0.07	2.55	42.0
Forty-four Creek	06A	8/18/2009	41.22041	124.01464	4.8	0.03	1.21	7.9
Forty-four Creek	06B	9/15/2009	41.21619	124.04582	6.7	0.01	0.21	1.3
Godwood Creek	17A	9/22/2009	41.37399	124.02930	1.8	-	-	2.6
Godwood Creek	17B	9/30/2009	41.36555	124.02360	1.2	0.02	0.79	3.5
Emerald Creek	10U	9/3/2009	41.19960	123.99219	4.5	0.00	0.13	7.6
Emerald Creek	10B	8/5/2009	41.20396	123.98994	3.3	0.01	0.29	6.9
Little Lost Man Creek	02T	9/23/2009	41.32122	124.02052	6.4	-	-	10.0
Little Lost Man Creek	02K	10/2/2009	41.31715	124.01644	2.9	0.01	0.18	9.5
Lost Man Creek	07K	9/24/2009	41.32122	123.99451	2.9	0.02	0.74	15.2
Lost Man Creek	07J	9/20/2009	41.32902	124.02232	0.7	0.04	1.43	27.7
May Creek	01B	8/13/2009	41.35497	124.00925	2.2	0.00	0.12	1.9
May Creek	01A	8/20/2009	41.35361	123.99866	3.3	0.00	0.04	0.9
Redwood Creek	16A	9/16/2009	41.19730	123.99313	0.2	0.41	14.37	620.0
Redwood Creek	16B	9/17/2009	41.27925	124.03004	< 0.1 *	0.43	15.33	702.0
West Branch Mill Creek	102	8/27/2009	41.68706	124.06488	7.6	0.01	0.38	3.9
West Branch Mill Creek	103	9/8/2009	41.71928	124.10844	1.0	0.05	1.65	21.9

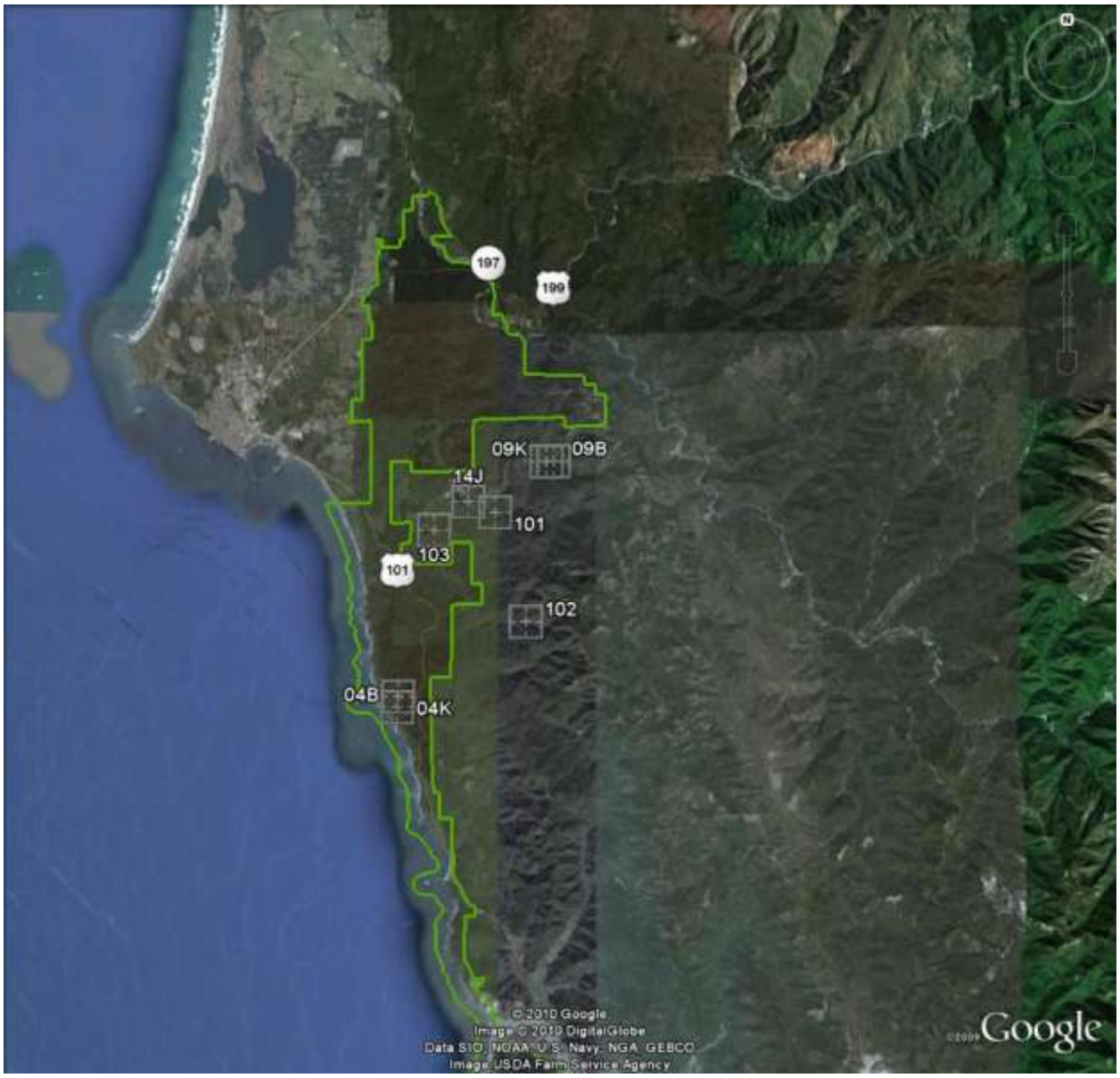

Figure 1. Sites sampled in the northern portion of REDW in the pilot project. The green line indicates the park boundary of the National Park; sites that are outside were sampled in state parks (boundaries not represented). Site codes are presented in Table 1.

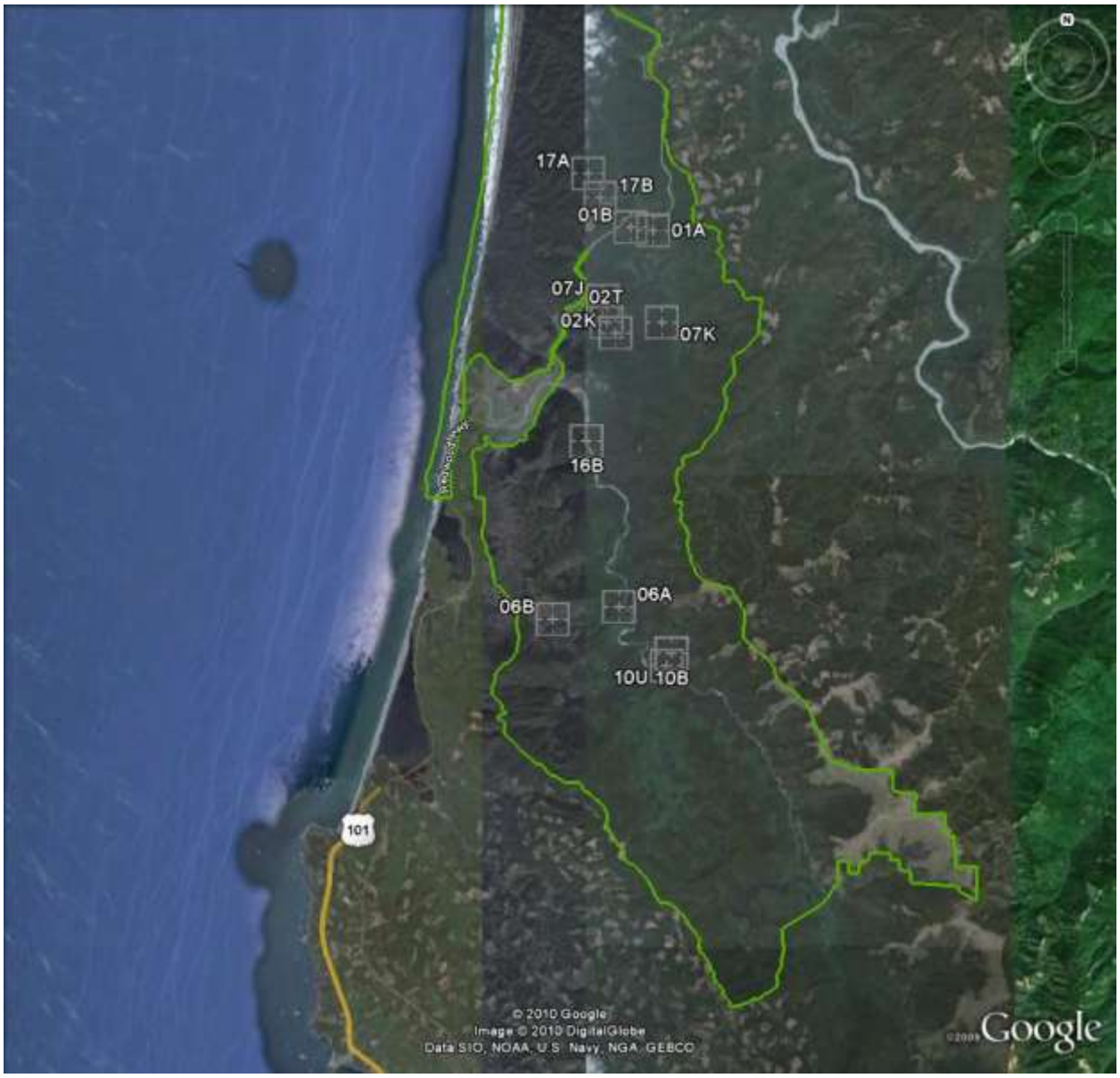

Figure 2. Sites sampled in the southern portion of REDW in the pilot project. The green line indicates the park boundary of the National Park; sites that are outside were sampled in state parks (boundaries not represented). Site codes are presented in Table 1.

Discharge measurements were made at the most ideal location (laminar flow, no obstructions) along a cross-section profile of between 10 to 20 equidistant points using a Flowtracker ADV flowmeter.

Slope was measured using an Abney Level and stadia rod for each inter-transect distance and the total elevational change summed for the reach to calculate the gradient.

Aquatic Communities

Aquatic macroinvertebrates were collected using a target riffle composite sampling technique. Eight separate samples (1 ft^2) at random riffles (or high velocity) were collected using a 500 µm

mesh net. Samples were composited, preserved in 95% Ethanol, and sent to the National Aquatic Monitoring Center, Utah State University, Logan, Utah. Macroinvertebrates were identified to the lowest practical level and expressed in individuals per square meter.

Fish and amphibians were sampled by snorkeling the reach. In habitats not deep enough to allow snorkeling, these habitats were either bypassed or observed by submerging the head in the deepest portions. Additional observations made while walking the reach were also made using Visual Encounter Survey techniques.

At three sites (East Fork Mill Creek [101], Redwood Creek [16A], and West Branch Mill Creek [103]), we were able to electrofish with David Anderson, Fisheries Biologist at REDW, under his permits. At these sites, three crew members did a single pass through the entire reach using a Smith-Root LR-24 backpack electrofisher.

Derived Metrics

Indices of biotic integrity (also called multi-metric models by the EPA) were calculated for macroinvertebrate and vertebrate samples. For macroinvertebrates, we utilized the North Coastal California model by Rehn et al. (2005), a regional model developed by the state of California, and the west-wide mountain model (Stoddard et al. 2005). The west-wide invertebrate EPA model was done on the entire dataset and not on a random draw of 300 individuals. For vertebrates, we utilized the EPA EMAP vertebrate west-wide model (Stoddard et al. 2005). Stream condition was assessed using the ranking scale of Rehn et al. (2005): 0 – 20 Very Poor; 21 – 40 Poor; 41 – 60 Fair; 61 – 80 Good; 81 – 100 Very Good. Caution should be used in application of this scale to the EPA models; however, they do provide a general indication of the stream condition. Full details of how these metrics are calculated are provided in the protocol (Dinger et al., in review [this document]).

Water Quality Exceedances

Measured values of water quality (temperature, acid neutralizing capacity, chloride, total nitrogen, sodium, sulfate, pH, and turbidity) were compared to state and national standards (Table 2.)

Table 2. Water quality standards used for assessing exceedances for the NPS, California and EPA.

Parameter	NPS Standards	California	EPA Standards			
		Drinking Water	Drinking Water	Health Advisory	National Ambient Water Quality Criteria	Region 10 Collaborative Guidance
Acid neutralizing capacity (mg/l) (alkalinity in standards)	> 25				> 20	
Chloride (mg/l)		< 250 mg/l			<230[1,4] , <860[2,4] - when associated only with NA	
Dissolved Oxygen (mg/l)	> 4				> 8.0 1 day minimum (water column)	
Total Nitrogen (as NO2 + NO3) (mg/l)		< 10	< 10			
pH	> 6.5		6.5 to 8.5		5 to 9*, 6.5 to 9&(max)	
Sodium (mg/l)				20		
Sulfate (mg/l)			500		250[3]	
Temperature, (fall, winter, spring) (7 day average of daily maximum)						< 9 °C (Bull trout); < 13 °C (general salmon and trout); < 14 °C (Steelhead)
Temperature, maximum (7 day average of daily maximum)						< 12 °C (Bull trout); < 16 °C (salmon and trout core rearing); < 18 °C (salmon and trout noncore rearing); < 20 °C (salmon and trout migration)
Turbidity (NTU)	< 50	< 1	< 1			

[1]Standard for Freshwater Aquatic Life Protection (4 day average); [2]Maximum 1 hour concentration; [3]Taste and odor standards; [4]Chloride standards only apply when dominant cation is Sodium.

Results

A total of 22 sampling sites were visited from 18 August to 30 September 2009. Sites were successfully sampled in a single day visit with a three person crew when vertebrate sampling was limited to snorkeling and visual encounter surveys. When electrofishing was possible under the permit of David Anderson, a total of four people were necessary to accomplish all tasks.

Stream Habitat Characterization

Stream sites sampled ranged from wide (Redwood Creek site 16B at 25.8 meters) to narrow (May Creek at 0.7 meters) (Table 3). Boulders and overhanging vegetation were the dominant sources of instream habitat cover. There was no cover observed from artificial substrates and macrophytes (in the form of moss) were only present in Godwood Creek. The most overall instream cover was in Little Lost Man Creek (100.7%) and lowest in Redwood Creek (19.5%). Discharge and slope are presented in Table 1.

Water Chemistry

Temperature measured during the field visit ranged from 9.8 °C (Godwood Creek) to 17.5 °C (Redwood Creek) (Table 4). However, these temperatures are instantaneous measurements and do not represent the diel or seasonal variation in water temperatures. Turbidity was low in many sites (0.1 NTU in Little Lost Man Creek) and was high in May Creek (124.8 NTU). At four sites, recorded turbidity resulted in negative values and is not presented here. Attempts to calibrate the dissolved oxygen probe of the multiprobe resulted in errors and were impossible to calibrate at *all sites.* The probe was judged to be broken and dissolved oxygen is not presented here because of this. At four sites, we were unable to collect water chemistry samples; reasons included broken filtration equipment, no prepared filters, and streams too shallow to fill the water sample bottle without contamination.

Aquatic Communities

A total of 17,677 individual macroinvertebrates from 153 distinct genera were identified by the contract laboratory (Appendix).

A total of five amphibian species were observed: Foothill Yellow-legged Frog (*Rana boylii*), Olympic Salamander (*Rhyacotriton olympicus*), Pacific Giant Salamander (*Dicamptodon ensatus*), Tailed Frog (*Ascaphus truei*), and Western Toad (*Bufo boreas*). Of these, the Pacific Giant Salamander was the most ubiquitous (17 sites), and the Olympic Salamander was the rarest (single site: Godwood Creek) (Table 5).

Eight distinct fish species were observed snorkeling, however, but life stages prohibited the identification of all species (Table 6). Species confirmed were: Coho Salmon (*Oncorhynchus kisutch*), Cutthroat trout (*Oncorhynchus clarki*), Steelhead trout (*Oncorhynchus mykiss*), and Three Spine Stickleback (*Gasterosteus aculeatus*). Lamprey ammocetes (larval fish) were observed only when electrofished, but the life stage prevented species identification. Sculpin were similarly only observed with electrofishing. Additional observations while snorkeling included unidentified fish, including a sucker species (family Catostomidae), an unidentified Salmonidae, and one specimen that was not seen long enough for even a preliminary identification.

Table 3. Physical habitat characteristics measured during the pilot project. Unique site codes are as in Table 1, Figures 2 and 3. Emb. = embeddedness. Sum of all categories is a measure of total habitat cover and can exceed 100%.

				In-Stream Habitat Cover (%)											
Stream Name	Unique Site Code	Wetted Width (m)	Average depth (m)	Artificial Substrate	Boulders	Filamentous algae	Large Wood	Macrophytes	Overhanging vegetation	Roots	Small Wood	Undercut Bank	Sum of all categories	Overhead shading (%)	Emb. (%)
Bummer Lake Creek	09B	4.8	22.8	0.0	58.0	11.8	5.0	0.0	8.9	0.9	3.2	0.5	88.2	90.1	18.2
Bummer Lake Creek	09K	7.3	22.6	0.0	51.4	0.0	12.5	0.0	5.0	10.0	7.7	0.5	87.0	90.9	24.7
Damnation Creek	04B	2.4	19.2	0.0	3.2	0.0	8.2	0.0	16.1	12.7	13.2	2.3	55.7	89.3	20.2
Damnation Creek	04K	2.5	18.4	0.0	4.5	0.0	6.4	0.0	53.0	23.2	4.5	2.3	93.9	94.4	27.4
East Fork Mill Creek	101	9.1	19.8	0.0	14.1	12.3	0.9	0.0	7.3	19.1	0.5	7.7	61.8	57.3	14.0
East Fork Mill Creek	14J	7.4	11.1	0.0	9.1	0.0	6.8	0.0	9.5	8.2	2.3	2.7	38.6	81.1	26.7
Forty-four Creek	06A	3.4	14.4	0.0	11.1	0.0	17.7	0.0	29.5	1.8	8.9	5.2	74.3	91.3	57.1
Forty-four Creek	06B	1.3	15.7	0.0	0.0	0.0	8.9	0.0	28.9	15.5	25.7	9.1	87.9	97.9	53.8
Godwood Creek	17A	3.3	11.3	0.0	0.0	0.0	8.4	6.1	28.4	11.6	4.1	17.2	75.9	89.6	26.4
Godwood Creek	17B	3.7	11.3	0.0	0.0	0.0	9.1	2.3	10.5	4.1	8.6	4.1	38.6	96.0	27.7
Emerald Creek	10U	2.3	10.5	0.0	48.4	0.0	24.1	0.0	8.4	7.3	5.0	5.0	98.2	88.4	26.2
Emerald Creek	10B	4.3	9.8	0.0	1.4	0.0	19.5	0.0	11.1	15.2	4.6	13.0	64.8	81.8	27.5
Little Lost Man Creek	02T	3.2	9.1	0.0	68.4	0.0	8.9	0.0	17.0	3.2	3.2	0.0	100.7	88.0	62.1
Little Lost Man Creek	02K	3.3	9.0	0.0	16.8	0.0	15.9	0.0	7.7	6.4	6.6	10.7	64.1	92.5	64.9
Lost Man Creek	07K	5.1	15.3	0.0	29.8	0.0	24.3	0.0	3.6	3.2	6.4	1.4	68.6	72.7	59.3
Lost Man Creek	07J	7.3	15.8	0.0	0.0	0.0	14.8	0.0	11.8	1.4	3.6	0.0	31.6	90.2	56.9
May Creek	01B	2.7	9.2	0.0	0.0	0.5	6.4	0.0	32.0	6.8	23.0	6.1	74.8	85.3	60.4
May Creek	01A	0.7	3.6	0.0	2.3	0.0	5.0	0.0	20.5	1.4	8.2	5.0	42.3	85.2	73.1
Redwood Creek	16A	18.9	11.3	0.0	5.5	2.3	5.5	0.0	4.1	0.5	1.8	0.0	19.5	41.8	27.6
Redwood Creek	16B	25.8	10.0	0.0	0.0	2.3	2.7	0.0	12.0	9.5	8.2	0.9	35.6	23.0	27.0
West Branch Mill Creek	102	3.3	12.1	0.0	44.5	0.0	23.2	0.0	2.3	11.6	5.5	0.0	87.0	90.1	31.8
West Branch Mill Creek	103	4.8	11.7	0.0	0.6	18.1	7.3	0.0	15.2	13.4	7.7	2.5	64.8	70.2	28.6

Table 4. Water chemistry parameters measured in the pilot project. Temperature, conductivity, pH, and turbidity were measured using a Eureka Environmental multiprobe. Water chemistry nutrients, anions, and cations were analyzed by the Cooperative Chemical Analytical Laboratory. NTU = Nephlometric turbidty units; N = total nitrogen, P = total phosphorous, Na = sodium, K = potassium, Ca = calcium, Mg = magnesium, SO4 = sulfate, and Cl = chloride. NA = not available. * indicates turbidity was a negative measurement.

							Water Chemistry (mg/l)							
Stream Name	Unique Site Code	Temperature (°C)	Specific Conductivity (ms/cm)	pH	Turbidity (NTU)	Acid neutralizing capacity (in mg/l of $CaCO_3$)	N	P	Na	K	Ca	Mg	SO4	Cl
Bummer Lake Creek	09B	11.9	0.0740	7.5	8.5	28.3	NA	NA	NA	NA	NA	NA	NA	NA
Bummer Lake Creek	09K	12.2	0.0696	7.5	6.9	25.0	0.23	0.02	3.49	0.31	3.35	4.87	0.80	3.33
Damnation Creek	04B	12.4	0.1287	7.3	1.0	27.3	0.14	0.02	10.89	0.64	8.34	2.92	2.14	15.80
Damnation Creek	04K	11.8	0.1137	7.2	*	25.0	0.14	0.02	10.44	0.64	7.89	2.66	2.07	15.18
East Fork Mill Creek	101	12.8	0.0879	7.4	0.3	27.3	0.08	0.01	4.04	0.42	4.75	2.68	0.89	4.20
East Fork Mill Creek	14J	11.8	0.0640	7.2	*	23.0	0.11	0.02	3.86	0.38	4.66	2.50	0.85	3.86
Forty-four Creek	06A	12.3	0.0451	6.9	94.6	14.2	0.16	0.02	4.20	0.38	3.57	1.16	0.52	5.55
Forty-four Creek	06B	12.3	0.0510	7.0	41.9	10.0	0.29	0.02	4.56	0.46	2.51	1.14	0.53	6.65
Godwood Creek	17A	9.8	0.1050	7.7	7.1	46.8	0.09	0.04	8.50	0.62	6.54	6.71	0.82	10.99
Godwood Creek	17B	11.8	0.1260	7.3	8.1	44.2	0.08	0.03	8.45	0.57	6.25	6.39	0.82	10.96
Emerald Creek	10U	13.1	0.1003	7.1	*	33.8	0.08	0.02	5.59	0.61	11.54	2.21	2.20	5.87
Emerald Creek	10B	14.1	0.1061	7.4	37.1	15.0	NA	NA	NA	NA	NA	NA	NA	NA
Little Lost Man Creek	02T	12.6	0.0732	7.0	2.4	23.8	0.1	0.02	6.37	0.62	5.55	2.05	0.77	6.44
Little Lost Man Creek	02K	10.2	0.0735	7.4	0.1	23.3	NA	NA	NA	NA	NA	NA	NA	NA
Lost Man Creek	07K	12.9	0.0798	7.1	6.1	30.7	0.20	0.02	5.75	0.65	7.44	2.10	1.12	5.34
Lost Man Creek	07J	12.5	0.0730	7.4	2.4	24.6	0.13	0.02	5.75	0.58	5.70	2.23	0.81	5.46
May Creek	01B	12.1	0.0920	7.4	124.8	38.0	0.16	0.02	6.64	0.57	7.47	3.77	0.42	6.76
May Creek	01A	13.1	0.1026	7.1	34.2	33.0	0.13	0.02	6.18	0.53	6.80	3.31	0.36	6.03
Redwood Creek	16A	16.8	0.1581	7.9	9.4	60.7	0.07	0.01	2.90	0.36	20.74	1.79	2.24	3.28
Redwood Creek	16B	17.5	0.1490	7.6	8.1	54.7	0.11	0.01	4.41	0.61	22.02	2.63	2.52	4.48
West Branch Mill Creek	102	13.6	0.0500	7.1	*	22.5	NA	NA	NA	NA	NA	NA	NA	NA
West Branch Mill Creek	103	12.1	0.0734	7.2	1.6	16.2	0.10	0.02	3.33	0.43	3.23	0.89	0.39	3.44

Table 5. Amphibians observed during the pilot project.

Stream Name	Unique Site Code	Sample method	Foothill Yellow Legged Frog	Olympic Salamander	Pacific Giant Salamander	Tailed Frog	Western Toad
Bummer Lake Creek	09B	Snorkel			X		
Bummer Lake Creek	09K	Snorkel			X		
Damnation Creek	04B	Snorkel			X	X	
Damnation Creek	04K	Snorkel			X	X	
East Fork Mill Creek	101	Electrofished			X		
East Fork Mill Creek	14J	Snorkel					
Forty-four Creek	06A	Snorkel			X	X	X
Forty-four Creek	06B	Snorkel					
Godwood Creek	17A	Snorkel		X	X	X	
Godwood Creek	17B	Snorkel			X	X	
Emerald Creek	10U	Snorkel	X		X	X	X
Emerald Creek	10B	Snorkel	X		X	X	X
Little Lost Man Creek	02T	Snorkel			X		
Little Lost Man Creek	02K	Snorkel			X		
Lost Man Creek	07K	Snorkel			X		
Lost Man Creek	07J	Snorkel					
May Creek	01B	Snorkel			X	X	
May Creek	01A	Snorkel			X		
Redwood Creek	16A	Electrofished	X				X
Redwood Creek	16B	Snorkel	X				X
West Branch Mill Creek	102	Snorkel	X		X		
West Branch Mill Creek	103	Electrofished			X		

Indices of Biotic Integrity indicated that all streams sites sampled are in “Good” (20 sites) or “Very Good” (2 sites) condition using the California Northern Coastal Region IBI; 13 sites in “Good” and eight sites in “Very Good” using the EPA West Wide Invertebrate index; and one site categorized as “Fair” – Redwood Creek (16B) (Table 7). Although the EPA Vertebrate index was only calculated at the three sites that were electrofished, two sites were rated “Very Good” and one site “Good.”

Table 6. Fish species observed during pilot project. UNID = unidentified.

Stream Name	Unique Site Code	Sample method	Coho Salmon	Cutthroat Trout	Lamprey	Rainbow Trout	Sculpin	Steelhead	Sucker	Three Spine Stickleback	UNID fish	UNID Trout
Bummer Lake Creek	09B	Snorkel		X				X				
Bummer Lake Creek	09K	Snorkel		X				X				
Damnation Creek	04B	Snorkel				X						
Damnation Creek	04K	Snorkel										X
East Fork Mill Creek	101	Electrofished	X		X		X	X		X		
East Fork Mill Creek	14J	Snorkel	X					X		X		
Forty-four Creek	06A	Snorkel		X				X				X
Forty-four Creek	06B	Snorkel						X				
Godwood Creek	17A	Snorkel						X				
Godwood Creek	17B	Snorkel	X	X				X		X		
Emerald Creek	10U	Snorkel		X				X				
Emerald Creek	10B	Snorkel		X				X				
Little Lost Man Creek	02T	Snorkel						X				
Little Lost Man Creek	02K	Snorkel	X					X				
Lost Man Creek	07K	Snorkel	X					X				
Lost Man Creek	07J	Snorkel	X	X				X		X		
May Creek	01B	Snorkel	X	X								
May Creek	01A	Snorkel	X								X	
Redwood Creek	16A	Electrofished			X		X	X		X		
Redwood Creek	16B	Snorkel						X	X	X		
West Branch Mill Creek	102	Snorkel		X								
West Branch Mill Creek	103	Electrofished	X		X		X	X		X		

Table 7. Indices of biotic integrity for sites sampled in pilot project. General categorical condition assessment is based on the scale: 0 – 20, “Very Poor”; 21 – 40, “Poor”; 41 – 60, “Fair”; 61 – 80, “Good”; and 81 – 100, “Very Good”, using the scale of Rehn et al. (2005). * indicates site not electrofished, so vertebrate index not applied.

Stream Name	Unique Site Code	California Northern Coastal Region B-IBI	EPA West Wide Invertebrate	EPA West Wide Vertebrate
Bummer Lake Creek	09B	75.0	72.0	*
Bummer Lake Creek	09K	68.8	84.8	*
Damnation Creek	04B	71.3	70.8	*
Damnation Creek	04K	80.0	79.1	*
East Fork Mill Creek	101	76.3	81.0	79.3
East Fork Mill Creek	14J	82.5	82.1	*
Forty-four Creek	06A	75.0	77.6	*
Forty-four Creek	06B	73.8	77.4	*
Godwood Creek	17A	76.3	78.7	*
Godwood Creek	17B	76.3	74.7	88.7
Emerald Creek	10U	76.3	83.2	*
Emerald Creek	10B	80.0	79.6	*
Little Lost Man Creek	02T	77.5	81.1	*
Little Lost Man Creek	02K	78.8	83.9	*
Lost Man Creek	07K	68.8	90.5	*
Lost Man Creek	07J	81.3	84.1	*
May Creek	01B	77.5	64.9	*
May Creek	01A	75.0	68.1	*
Redwood Creek	16A	75.0	75.5	*
Redwood Creek	16B	72.5	52.8	*
West Branch Mill Creek	102	72.5	75.0	*
West Branch Mill Creek	103	72.5	70.1	82.7

Discussion

The application of water quality standards to REDW shows the need for site-specific interpretation of these standards. Acid neutralizing capacity, a measure of the ability of a water body to resist changes in pH, is below the NPS threshold for eight of the 22 sites sampled. However, all sampled sites had pH within the regulatory thresholds for both freshwater aquatic life standards and drinking water. The low alkalinities observed in REDW are more likely a function of limited watershed and stream length, since the source of carbonates responsible for alkalinity in stream waters is through erosion of the geologic basin (Allan and Castillo 2007). In small coastal basins, there is limited absorption of these carbonates from the bedrock, limiting the acid neutralizing capacity in REDW. Hence, the low alkalinities in REDW do not indicate pollution or degradation; however, they do highlight the poor buffering capacity of these streams, thereby suggesting high susceptibility to pollution-driven acidification (e.g., acid rain or acid mine drainages).

Turbidity standards were exceeded in most streams based on drinking water standards. The more applicable NPS standards were only exceeded in two streams (Forty-four Creek [06A] and May Creek [01B]). The turbidity probe also proved difficult to maintain, with several sites producing negative values of turbidity. Based on these results, the implemented protocol will include more frequent calibrations of the turbidity probe. However, the observed problems in the pilot project of maintaining an accurate calibration suggest that limited interpretation should be made from the pilot project.

Among other water quality standards, there were no exceedances in: Chloride, Total nitrogen, pH, Sodium, or Sulfate. Problems with the dissolved oxygen probe prevented reporting of values and the application of standards.

Stream water temperature standards are based on 7 day averages, but here we take single point measurements, which do not capture the daily or seasonal variability of water temperatures. However, we suggest that our single time measurements, if above the regulatory average, should be taken as an indication that requires follow-up studies. For the pilot project, only Redwood Creek (both sites) with temperatures over 16 °C (the maximum 7 day average for core salmon and trout rearing streams based on EPA Region 10 collaborative guidance) was over the threshold. Indeed, Redwood Creek is listed as a water quality impaired site (303d) based on elevated temperatures. Potential stressors identified in increased temperatures include: logging road construction/maintenance, removal of riparian vegetation, streambank modifications, erosion/siltation, natural and non-point sources (California 303d list 2006).

Macroinvertebrate collections using the targeted riffle techniques proved doable in all habitats and generated a rich collection of taxa. However, recent work by the California Department of Fish and Game has shown certain advantages of using a “reach-wide benthos” technique, which incorporates semi-quantitative sampling of pool and slack water habitats (Rehn et al. 2007). This has changed the focus of the EPA EMAP program to eliminate the targeted riffle technique and implement only the reach-wide benthos sampling. Based on this, we have switched from the original targeted riffle technique used in the pilot project to the reach-wide benthos for the final implementation of the sampling protocol. Rehn et al. (2007) suggest that although the original

indexes were based on targeted riffle techniques, the use of reach-wide benthos sampling data can be used interchangeably, but that the reach-wide benthos technique was generally more precise (although not substantially more). The reach-wide benthos has additional advantages of being applicable in a larger range of stream types (slow moving streams) and does not require the field crews to precisely identify riffles.

Results of the Northern California Coastal IBIs suggest that the streams of REDW are all at least in "Good" condition, with some sites in the "Very Good" category. The application of the EPA threshold of "52" to indicate impairment (<52: unimpaired; ≥52 impaired) from Stoddard et al. (2005) shows that no sites within REDW are impaired based on macroinvertebrate assessment.

The EPA invertebrate model gives similar results to the Northern California Coastal model, but for the purpose of this draft example of an annual report, we were not able to implement a random draw component of the draft database prior to protocol submission (SOP #22: Data Analysis and Reporting). The metric should be calculated only on the random draw subset for each sample as a step to standardize for density differences and subsampling. Hence, the results presented here should only be used a sample of the type of metric to be included in protocol implementation.

Although the Northern California Coastal IBI gave similar results to the EPA invertebrate model (with the above qualifier in place), there was one notable exception at Redwood Creek (16B), where the Northern California Coastal IBI was 72.5 (Good) and the EPA model was 52.8 (Fair). This corresponds to the observed pattern of the North Coast Regional Water Quality Control Board, which found that the Northern California Coastal model was useful for assessing stream conditions for urban or agricultural impacts but did not accurately assess impacts from timber harvest industries. This highlights the need for using multiple assessment methodologies for assigning water quality condition. In this case, Redwood Creek is a known 303(d) site impacted by timber harvest activities.

Calculations of observed/expected models (O/E) of taxonomic completeness (Hawkins et al. 2000) were also not able to be implemented prior to protocol submission. Annual reports during implementation will include this valuable metric that measures observed biodiversity when compared to expected biodiversity in reference conditions.

The sampling procedures from the draft protocol proved doable with a three person crew. However, the quality of the data obtained by electrofishing shows the necessity of using a four person crew with the ability to electrofish. For instance, snorkeling, when compared to electrofishing, missed Sculpin and Lampreys. Electrofishing also provided greater ability to identify the fish of each site. Hence, electrofishing provided greater taxonomic resolution, and a more complete and accurate assessment of the species present in the park ecosystems.

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Appendix. Taxonomic results of macroinvertebrates and identified by contract laboratory. ITIS code = Integrated Taxonomic Information System (www.itis.gov) Taxonomic Serial Number, a unique serial number assigned to each taxon that provides updated taxonomy and status. Species where identification is not possible, but can be placed between two or more taxa (splits or species groups) do not have ITIS codes.

ITIS Code	Phylum	Class	Order	Family	Subfamily	Genus	Species
68422	Annelida	Clitellata					
83170	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		*Protzia*	
83172	Arthropoda	Arachnida	Trombidiformes	Hydryphantidae		*Wandesia*	
83297	Arthropoda	Arachnida	Trombidiformes	Hygrobatidae		*Hygrobates*	
83281	Arthropoda	Arachnida	Trombidiformes	Hygrobatidae			
83034	Arthropoda	Arachnida	Trombidiformes	Lebertiidae		*Lebertia*	
83006	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		*Sperchon*	
83029	Arthropoda	Arachnida	Trombidiformes	Sperchonidae		*Sperchonopsis*	
83005	Arthropoda	Arachnida	Trombidiformes	Sperchonidae			
83250	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		*Testudacarus*	
83254	Arthropoda	Arachnida	Trombidiformes	Torrenticolidae		*Torrenticola*	
82769	Arthropoda	Arachnida	Trombidiformes				
99237	Arthropoda	Entognatha	Collembola				
109234	Arthropoda	Insecta	Coleoptera	Carabidae			
114006	Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus*	
112314	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae	*Oreodytes*	
728253	Arthropoda	Insecta	Coleoptera	Dytiscidae		*Sanfilippodytes*	
114197	Arthropoda	Insecta	Coleoptera	Elmidae		*Ampumixis*	*dispar*
114168	Arthropoda	Insecta	Coleoptera	Elmidae		*Heterlimnius*	*koebelei*
114167	Arthropoda	Insecta	Coleoptera	Elmidae		*Heterlimnius*	
114137	Arthropoda	Insecta	Coleoptera	Elmidae		*Lara*	
114144	Arthropoda	Insecta	Coleoptera	Elmidae		*Narpus*	*concolor*
114142	Arthropoda	Insecta	Coleoptera	Elmidae		*Narpus*	
	Arthropoda	Insecta	Coleoptera	Elmidae		*Optioservus*	*divergens/pecosensis*
114180	Arthropoda	Insecta	Coleoptera	Elmidae		*Optioservus*	*quadrimaculatus*
114177	Arthropoda	Insecta	Coleoptera	Elmidae		*Optioservus*	
114236	Arthropoda	Insecta	Coleoptera	Elmidae		*Ordobrevia*	*nubifera*
114205	Arthropoda	Insecta	Coleoptera	Elmidae		*Zaitzevia*	

ITIS Code	Phylum	Class	Order	Family	Subfamily	Genus	Species
114093	Arthropoda	Insecta	Coleoptera	Elmidae			
111947	Arthropoda	Insecta	Coleoptera	Haliplidae		*Brychius*	
112757	Arthropoda	Insecta	Coleoptera	Hydraenidae		*Hydraena*	
112811	Arthropoda	Insecta	Coleoptera	Hydrophilidae			
708467	Arthropoda	Insecta	Coleoptera	Psephenidae	Eubrianacinae	*Eubrianax*	*edwardsii*
114082	Arthropoda	Insecta	Coleoptera	Psephenidae		*Acneus*	
114069	Arthropoda	Insecta	Coleoptera	Psephenidae			
130931	Arthropoda	Insecta	Diptera	Athericidae		*Atherix*	*pachypus*
127729	Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	*Probezzia*	
127113	Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	*Atrichopogon*	
127152	Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	*Forcipomyia*	
127076	Arthropoda	Insecta	Diptera	Ceratopogonidae			
129873	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Cladotanytarsus*	
129884	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Constempellina*	
129421	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Demicryptochironomus*	
129890	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Micropsectra*	
129535	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Microtendipes*	
129935	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Paratanytarsus*	
129657	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Polypedilum*	
129952	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Rheotanytarsus*	
129730	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Robackia*	
129872	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Tanytarsus*	
130038	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Zavrelia*	
129872	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		
129229	Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		
128401	Arthropoda	Insecta	Diptera	Chironomidae	Diamesinae	*Pagastia*	
	Arthropoda	Insecta	Diptera	Chironomidae	Diamesinae	*Potthastia*	*gaedii group*
128477	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Brillia*	
128520	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Chaetocladius*	
128563	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Corynoneura*	
568521	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Cricotopus*	*trifascia group*
128575	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Cricotopus*	
128689	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Eukiefferiella*	

ITIS Code	Phylum	Class	Order	Family	Subfamily	Genus	Species
128730	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Heleniella*	
128734	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Heterotanytarsus*	
128737	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Heterotrissocladius*	
128771	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Krenosmittia*	
128776	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Limnophyes*	
128811	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Lopescladius*	
128844	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Nanocladius*	
568523	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Orthocladius*	
128951	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Parachaetocladius*	
128968	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Parakiefferiella*	
128978	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Parametriocnemus*	
128989	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Paraphaenocladius*	
129018	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Psectrocladius*	
129052	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Pseudorthocladius*	
129071	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Pseudosmittia*	
129083	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Psilometriocnemus*	
129086	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Rheocricotopus*	
129161	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Synorthocladius*	
129182	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Thienemanniella*	
129197	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Tvetenia*	
128457	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae		
	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae		
127987	Arthropoda	Insecta	Diptera	Chironomidae	Podonominae	*Parochlus*	
128026	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Brundiniella*	
128207	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Paramerina*	
128215	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Pentaneura*	
128236	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Thienemannimyia group*	
128259	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Zavrelimyia*	
127994	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		
128078	Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		
125810	Arthropoda	Insecta	Diptera	Dixidae		*Dixa*	
125874	Arthropoda	Insecta	Diptera	Dixidae		*Meringodixa*	*chalonensis*
125809	Arthropoda	Insecta	Diptera	Dixidae			

ITIS Code	Phylum	Class	Order	Family	Subfamily	Genus	Species
136824	Arthropoda	Insecta	Diptera	Dolichopodidae			
136305	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	*Chelifera*	
136327	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	*Hemerodromia*	
	Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae		
135849	Arthropoda	Insecta	Diptera	Empididae		*Clinocera*	
136352	Arthropoda	Insecta	Diptera	Empididae		*Neoplasta*	
136377	Arthropoda	Insecta	Diptera	Empididae		*Oreogeton*	
135830	Arthropoda	Insecta	Diptera	Empididae			
146893	Arthropoda	Insecta	Diptera	Ephydridae			
130915	Arthropoda	Insecta	Diptera	Pelecorhynchidae		*Glutops*	
125392	Arthropoda	Insecta	Diptera	Psychodidae		*Maruina*	
125514	Arthropoda	Insecta	Diptera	Psychodidae		*Pericoma*	
125468	Arthropoda	Insecta	Diptera	Psychodidae		*Psychoda*	
125351	Arthropoda	Insecta	Diptera	Psychodidae			
126774	Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	*Simulium*	
126640	Arthropoda	Insecta	Diptera	Simuliidae			
130436	Arthropoda	Insecta	Diptera	Stratiomyidae		*Euparyphus*	
130150	Arthropoda	Insecta	Diptera	Stratiomyidae			
131527	Arthropoda	Insecta	Diptera	Tabanidae		*Tabanus*	
130934	Arthropoda	Insecta	Diptera	Tabanidae			
119660	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	*Antocha*	*monticola*
119704	Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	*Limonia*	
119037	Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	*Tipula*	
121027	Arthropoda	Insecta	Diptera	Tipulidae		*Dicranota*	
120094	Arthropoda	Insecta	Diptera	Tipulidae		*Hexatoma*	
118840	Arthropoda	Insecta	Diptera	Tipulidae			
118831	Arthropoda	Insecta	Diptera				
100996	Arthropoda	Insecta	Ephemeroptera	Ameletidae		*Ameletus*	
100801	Arthropoda	Insecta	Ephemeroptera	Baetidae		*Acentrella*	
100800	Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis*	
100873	Arthropoda	Insecta	Ephemeroptera	Baetidae		*Centroptilum*	
568598	Arthropoda	Insecta	Ephemeroptera	Baetidae		*Diphetor*	*hageni*
100755	Arthropoda	Insecta	Ephemeroptera	Baetidae			

ITIS Code	Phylum	Class	Order	Family	Subfamily	Genus	Species
	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		*Drunella*	*coloradensis/flavilinea*
101368	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		*Drunella*	*doddsii*
101385	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		*Drunella*	*spinifera*
101395	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		*Serratella*	
101318	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae		*Timpanoga*	*hecuba*
101232	Arthropoda	Insecta	Ephemeroptera	Ephemerellidae			
100598	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Cinygma*	
100557	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Cinygmula*	
100626	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Epeorus*	
100666	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Ironodes*	
100572	Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Rhithrogena*	
100504	Arthropoda	Insecta	Ephemeroptera	Heptageniidae			
101041	Arthropoda	Insecta	Ephemeroptera	Isonychiidae		*Isonychia*	
101405	Arthropoda	Insecta	Ephemeroptera	Leptohyphidae		*Tricorythodes*	
101187	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		*Paraleptophlebia*	
101095	Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae			
103829	Arthropoda	Insecta	Hemiptera	Gerridae	Gerrinae	*Gerris*	
103801	Arthropoda	Insecta	Hemiptera	Gerridae			
103885	Arthropoda	Insecta	Hemiptera	Veliidae			
115045	Arthropoda	Insecta	Megaloptera	Corydalidae		*Orohermes*	*crepusculus*
115023	Arthropoda	Insecta	Megaloptera	Corydalidae			
593042	Arthropoda	Insecta	Odonata	Cordulegastridae		*Cordulegaster*	*dorsalis*
101738	Arthropoda	Insecta	Odonata	Gomphidae		*Ophiogomphus*	
101664	Arthropoda	Insecta	Odonata	Gomphidae			
102643	Arthropoda	Insecta	Plecoptera	Capniidae	Capniinae		
103254	Arthropoda	Insecta	Plecoptera	Chloroperlidae	Chloroperlinae	*Suwallia*	
103236	Arthropoda	Insecta	Plecoptera	Chloroperlidae		*Kathroperla*	
103233	Arthropoda	Insecta	Plecoptera	Chloroperlidae		*Paraperla*	
103273	Arthropoda	Insecta	Plecoptera	Chloroperlidae		*Sweltsa*	
103202	Arthropoda	Insecta	Plecoptera	Chloroperlidae			
102910	Arthropoda	Insecta	Plecoptera	Leuctridae		*Moselia*	*infuscata*
102840	Arthropoda	Insecta	Plecoptera	Leuctridae			
102567	Arthropoda	Insecta	Plecoptera	Nemouridae		*Malenka*	

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102556	Arthropoda	Insecta	Plecoptera	Nemouridae		*Soyedina*	
102594	Arthropoda	Insecta	Plecoptera	Nemouridae		*Zapada*	*cinctipes*
102597	Arthropoda	Insecta	Plecoptera	Nemouridae		*Zapada*	*oregonensis group*
102591	Arthropoda	Insecta	Plecoptera	Nemouridae		*Zapada*	
102517	Arthropoda	Insecta	Plecoptera	Nemouridae			
102515	Arthropoda	Insecta	Plecoptera	Peltoperlidae		*Sierraperla*	*cora*
103142	Arthropoda	Insecta	Plecoptera	Peltoperlidae		*Soliperla*	
102510	Arthropoda	Insecta	Plecoptera	Peltoperlidae		*Yoraperla*	
102488	Arthropoda	Insecta	Plecoptera	Peltoperlidae			
102986	Arthropoda	Insecta	Plecoptera	Perlidae		*Calineuria*	*californica*
103123	Arthropoda	Insecta	Plecoptera	Perlidae		*Doroneuria*	*baumanni*
102972	Arthropoda	Insecta	Plecoptera	Perlidae		*Hesperoperla*	*pacifica*
102914	Arthropoda	Insecta	Plecoptera	Perlidae			
102995	Arthropoda	Insecta	Plecoptera	Perlodidae	Isoperlinae	*Isoperla*	
103102	Arthropoda	Insecta	Plecoptera	Perlodidae	Perlodinae	*Skwala*	
102994	Arthropoda	Insecta	Plecoptera	Perlodidae			
102473	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcyinae	*Pteronarcys*	*californica*
102471	Arthropoda	Insecta	Plecoptera	Pteronarcyidae	Pteronarcyinae	*Pteronarcys*	
102467	Arthropoda	Insecta	Plecoptera				
115935	Arthropoda	Insecta	Trichoptera	Apataniidae		*Apatania*	
116906	Arthropoda	Insecta	Trichoptera	Brachycentridae		*Brachycentrus*	
116958	Arthropoda	Insecta	Trichoptera	Brachycentridae		*Micrasema*	
116905	Arthropoda	Insecta	Trichoptera	Brachycentridae			
116538	Arthropoda	Insecta	Trichoptera	Calamoceratidae	Calamoceratinae	*Heteroplectron*	*californicum*
117121	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Agapetinae	*Agapetus*	
117159	Arthropoda	Insecta	Trichoptera	Glossosomatidae	Glossosomatinae	*Glossosoma*	
117120	Arthropoda	Insecta	Trichoptera	Glossosomatidae			
115529	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	*Arctopsyche*	
115563	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	*Parapsyche*	*almota*
115560	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	*Parapsyche*	*elsis*
115556	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Arctopsychinae	*Parapsyche*	
115453	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche*	
115398	Arthropoda	Insecta	Trichoptera	Hydropsychidae			

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115641	Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	*Hydroptila*	
115849	Arthropoda	Insecta	Trichoptera	Hydroptilidae		*Palaeagapetus*	
115629	Arthropoda	Insecta	Trichoptera	Hydroptilidae			
116794	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostomatinae	*Lepidostoma*	
116001	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	*Hesperophylax*	
115998	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	*Hydatophylax*	*hesperus*
115974	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	*Psychoglypha*	
115907	Arthropoda	Insecta	Trichoptera	Limnephilidae		*Cryptochia*	
115933	Arthropoda	Insecta	Trichoptera	Limnephilidae			
115319	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	*Dolophilodes*	
115258	Arthropoda	Insecta	Trichoptera	Philopotamidae	Philopotaminae	*Wormaldia*	
115257	Arthropoda	Insecta	Trichoptera	Philopotamidae			
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*angelita group*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*betteni group*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*brunnea/vemna group*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*grandis group*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*hyalinata group*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*sibirica group B*
	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	*vofixa group*
115097	Arthropoda	Insecta	Trichoptera	Rhyacophilidae		*Rhyacophila*	
117003	Arthropoda	Insecta	Trichoptera	Sericostomatidae		*Gumaga*	
116046	Arthropoda	Insecta	Trichoptera	Uenoidae	Thremmatinae	*Neophylax*	
116331	Arthropoda	Insecta	Trichoptera	Uenoidae	Uenoinae	*Farula*	
115095	Arthropoda	Insecta	Trichoptera				
99208	Arthropoda	Insecta					
93953	Arthropoda	Malacostraca	Amphipoda	Anisogammaridae		*Ramellogammarus*	
93861	Arthropoda	Malacostraca	Amphipoda	Crangonyctidae		*Stygobromus*	
93294	Arthropoda	Malacostraca	Amphipoda				
92120	Arthropoda	Malacostraca	Isopoda				
173546	Chordata	Amphibia	Anura	Leiopelmatidae		*Ascaphus*	*truei*
81400	Mollusca	Bivalvia	Veneroida	Pisidiidae	Pisidiinae	*Pisidium*	
76591	Mollusca	Gastropoda	Basommatophora	Planorbidae			
71584	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae		*Juga*	*bulbosa*

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71570	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae		*Juga*	
71541	Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae			
69459	Mollusca	Gastropoda					
563956	Nemata						
53964	Platyhelminthes	Turbellaria					

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov